



Analysis Details for a Higgs Recoil Mass Study using MOKKA and MarlinReco

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Outline

- Introduction
- Tools used; Likelihoods
- Analysis details && Applications
- PDF class
- Another Application



Our Collaboration

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(Hamburg): K. Wichmann

MPI (München): A. Raspereza

LAL (Orsay): H. Li, R. Pöschl, M. Ruan



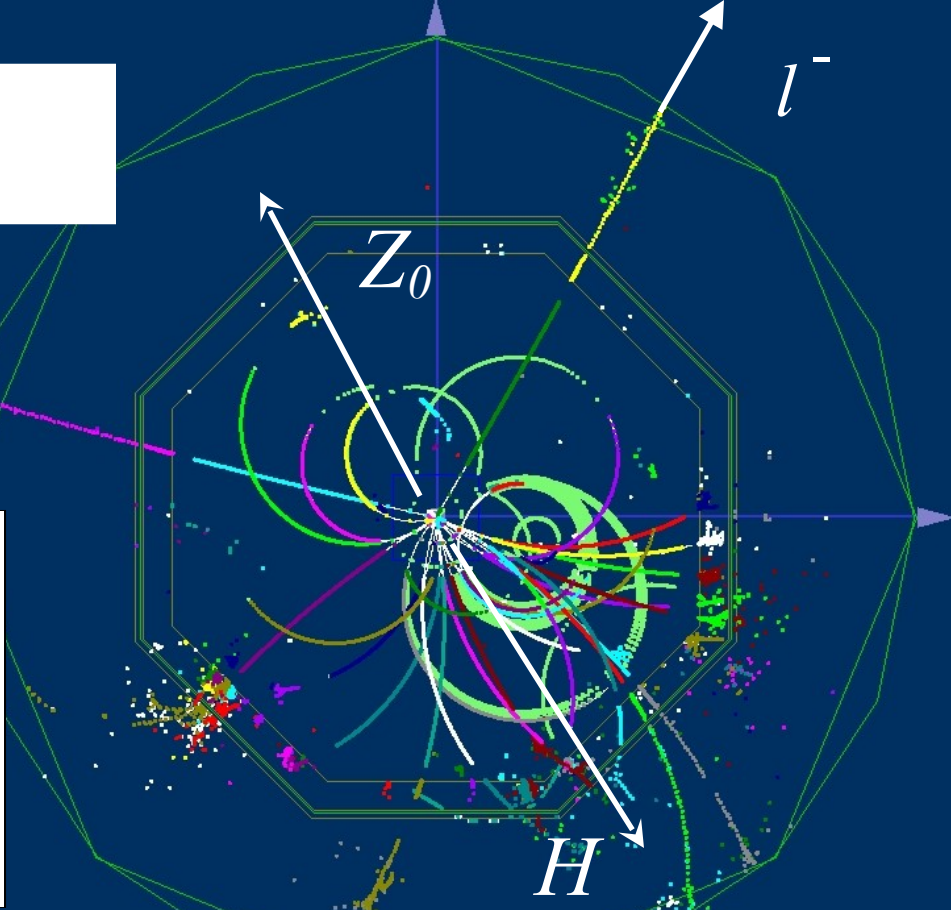
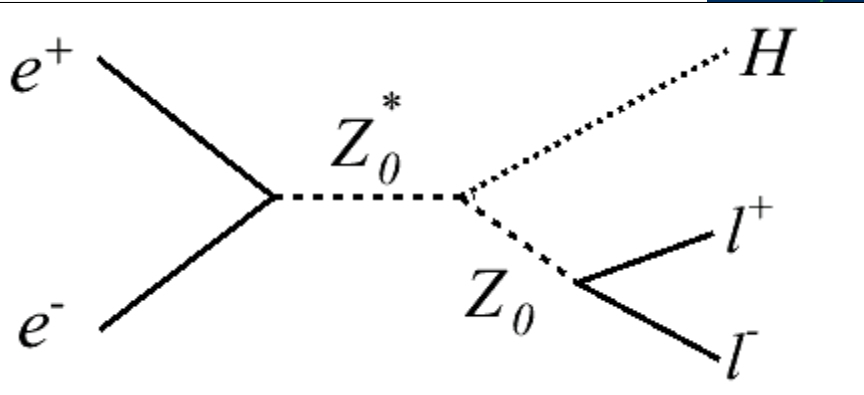
MAX-PLANCK-GESELLSCHAFT





Our Task

- Higgs-Strahlung-Process:



- Higgs-Recoil-Mass
- Coupling Strength (model independent)

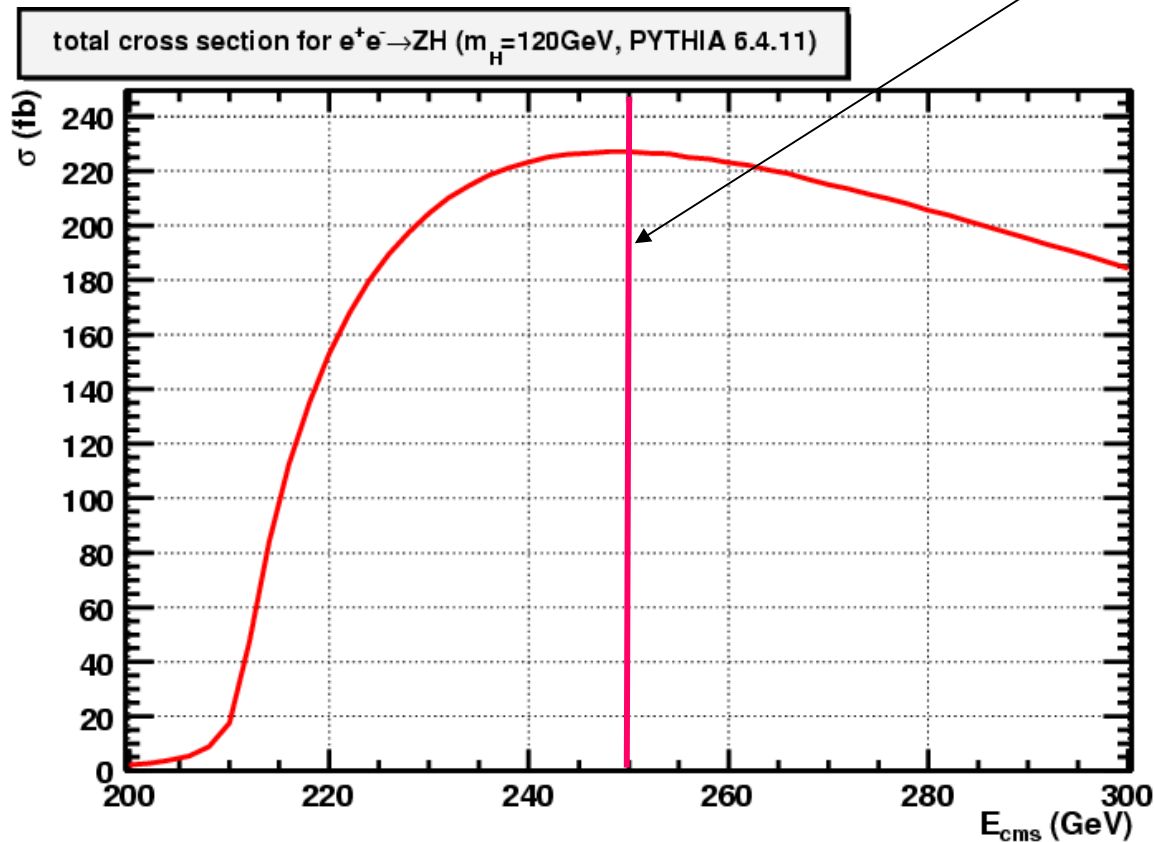
$$m_h^2 = s + m_Z^2 - 2E_Z \sqrt{s}$$

$$g_{ZZH}^2 \propto \sigma = N / L \mathcal{E}$$



For Our Studies ...

SM - Higgs boson: $m_H = 120 \text{ GeV}$, $E_{\text{cms}} = 250 \text{ GeV}$





Tools & Simulation Stages

Software for ILC / LDC (LDC01Sc)



- create events
- include BS, ISR, FSR

- detector-simulation

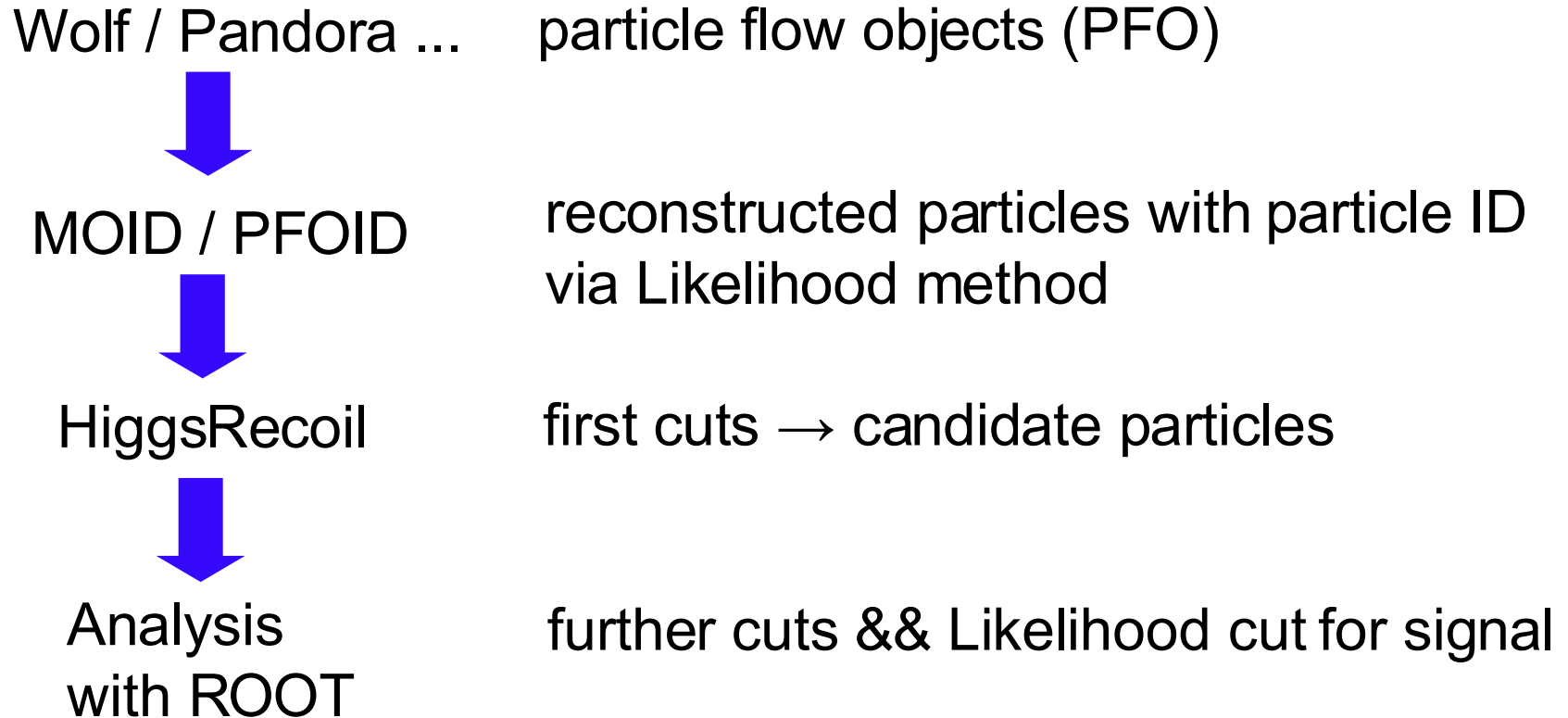
- full reconstruction of isolated leptons

↳ dilepton reconstruction

↳ Higgs Recoil Mass + Analysis



Detailed Analysis Steps





Likelihood method

N categories that differ in distribution of certain variables (say M)

$$f_i^k(\{x\}); i = 1, \dots, N$$

$$x_j; j = 1, \dots, M$$

- f 's are normalized, may depend on several of the variables && found by a gauging procedure; $k = 1, \dots, K$

- probability density functions for category i

$$p_i^k(\{x\}) = \frac{f_i^k(\{x\})}{\sum_{l=1}^N f_l^k(\{x\})}$$

- Likelihood for category i out of the values of the variables

$$L_i = \frac{\prod_j p_i^j}{\sum_{k=1}^N \prod_l p_k^l}$$



Particle ID - 1st Application

Marlin-Processors:

PFOID :

- creates new Reconstructed particle collection with particle IDs
- needs names of pdf files, RecoParticle collection from Wolf (...) && name for new RecoParticle collection

CreatePDFs :

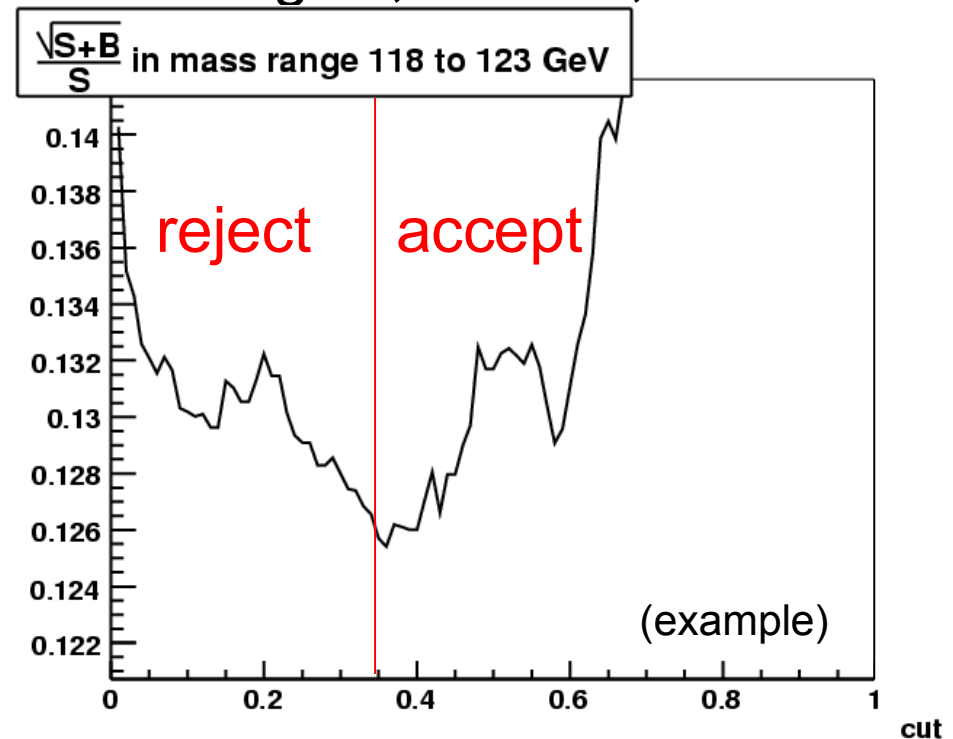
- creates pdf files for charged and neutral particles categories: e , μ , π ; γ , neutral hadrons
- needs MCParticle, RecoParticle collection, relationship collections, names for the pdf files, assignment arrays



Signal-Background Separation - 2nd Application

Higgs-Recoil-Mass analysis:

- signal + several different background events
= categories
- each with (different) distribution of angles, Z mass, ...
= distributions \rightarrow pdfs
- set cut to signal likelihood;
optimized for minimum
cross section errors





PDF class

- (small) class hierarchy;
- PDF contains Categories and a VObject that contains the variables (interface to outside);
- each Category contains histograms (arbitrary dimension);
- PDF has routines to fill these histograms and to calculate the Likelihood for a certain Category via VObject
- not perfect, and needs to be tested further



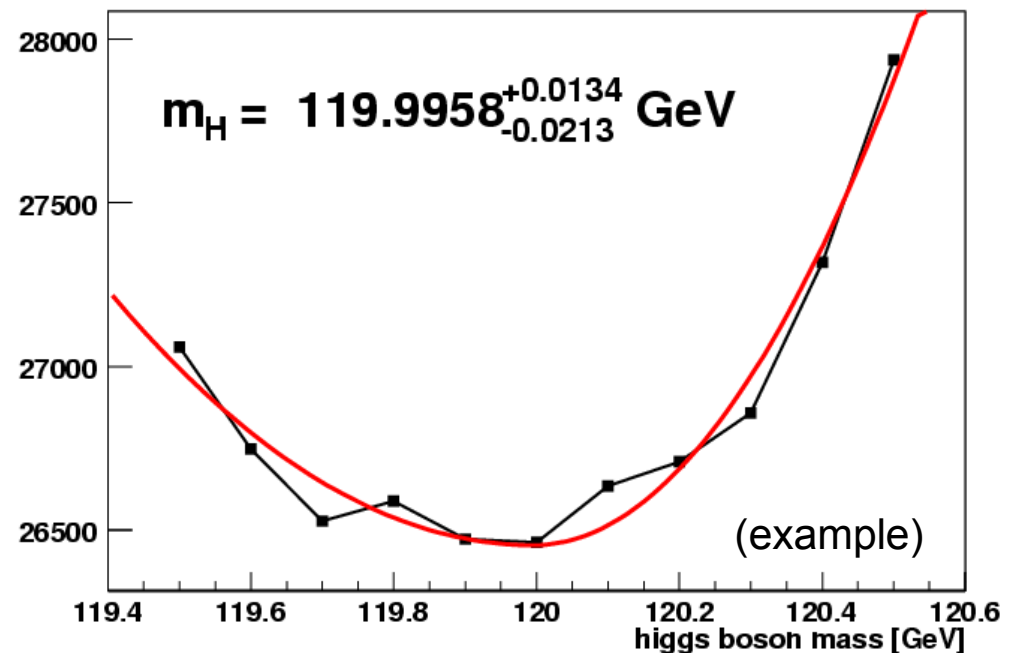
Higgs Mass Extraction - another Likelihood

- "data" sample && MC samples for different masses m_i
- MC samples passed through full simulation and reconstruction stages
→ Higgs Recoil Mass spectra for each Higgs Mass $h_{m_i}(m_r)$

Log(Likelihood)

- normalize spectra;
- calculate for each m_i the likelihood

$$L_{m_i} = \prod_{i; \text{Data}} \tilde{h}_{m_i}(m_{r;i})$$





Thanks to our collaborators!